Remarks

Claims 1-27 remain in the above captioned application. Claims 1-26 stand allowed. Claim 27 has been rejected under 25 U.S.C. §112, second paragraph. The Examiner has taken the position that claim 27 recites "'to occurs [sic] at relative times so that no significant lasing results'" is a "relative term which renders the claim indefinite. The Examiner states that this term "is not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention."

Applicants respectfully disagree.

While the portions of the Specification previously referenced in response to this identical rejection in the preceding Office Action should have sufficed, applicants point to the following portions of the Specification (referring to the Published Application, No. 2003/0099269, as the Examiner has) to more clearly demonstrate that the Specification contains sufficient information for one of ordinary skill in the art to understand the scope and meaning of "no significant lasing" in the above referenced phrase in claim 27:

> [0069] Monitor Timing
>
> [0070] The timing of the discharges can be monitored on a pulse-to-pulse basis and the time difference can be used in a feedback control system to adjust timing of the trigger signals closing switch 42. Preferably, the PA discharge would be monitored using a photocell to observe discharge fluorescence (called ASE) rather than the laser pulse since very poor timing could result if no laser beam being produced in the PA. For the MO either the ASE or the seed laser pulse could be used.
>
> Burst Type Operation
>
> [0081] Feedback control of the timing is relatively easy and effective when the laser is operating on a continuous basis. However, normally lithography lasers operate in a burst mode such as the following to process 20 areas on each of many wafers:
>
> [0082] Off for 1.2 minutes to move a wafer into place
>
> [0083] 4000 Hz for 0.2 seconds to illuminate area 1
>
> [0084] Off for 0.3 seconds to move to area 2

[0085] 4000 Hz for 0.2 seconds to illuminate area 2

[0086] Off for 0.3 seconds to move to area 3

[0087] 4000 Hz for 0.2 seconds to illuminate area 3

[0088] 4000 Hz for 0.2 seconds to illuminate area 199

[0089] Off for 0.3 seconds to move to area 200

[0090] 4000 Hz for 0.2 seconds to illuminate area 200

[0091] Off for one minute to change wafers

[0092] 4000 Hz for 0.2 seconds to illuminate area 1 on the next wafer, etc.

[0093] This process may be repeated for many hours, but will be interrupted from time-to-time for periods longer or shorter than 1.2 minute.

[0094] The length of down times will affect the relative timing between the pulse power systems of the MO and the PA and adjustment may be required in the trigger control to assure that the discharge in the PA occurs when the seed beam from the MO is at the desired location. By monitoring the discharges and the timing of light out from each chamber the laser operator can adjust the trigger timing (accurate to within about 2 ns) to achieve best performance.

[0095] Preferably a laser control processor is programmed to monitor the timing and beam quality and adjust the timing automatically for best performance. Timing algorithms which develop sets of bin values applicable to various sets of operating modes are utilized in preferred embodiments of this invention. These algorithms are in preferred embodiments designed to switch to a feedback control during continuous operation where the timing values for the current pulse is set based on feedback data collected for one or more preceding pulse (such as the immediately preceding pulse).

No Output Discharge

[0096] Timing algorithms such as those discussed above work very well for continuous or regularly repeated operation. However, the accuracy of the timing may not be good in unusual situations such as the first pulse after the laser is off for wafer change or for longer periods such as 5

minutes. In some situations imprecise timing for the first one or two pulses of a burst may not pose a problem. A preferred technique is to preprogram the laser so that the discharges of the MO and the PA are intentionally out of sequence for one or two pulses so that amplification of the seed beam from the MO is impossible. For example, laser could be programmed to trigger the discharge of the PA 110 ns prior to the trigger of the MO. In this case, there will be no significant output from the laser but the laser metrology sensors can determine the timing parameters so that the timing parameters for the first output pulse is precise.

Applicants Test

[0097] Applicants have conducted careful experiments to measure the impact of the relative timing of the discharge of the master oscillator and the power amplifier. These tests are summarized in FIG. 5 in which the Applicants have plotted the pulse energy (in millijoules) of amplified stimulated emission (ASE) from the output of the power amplifier and the line narrowed output (also in milliJoules). Both plots are made as a function of delay between the beginning of discharge of the master oscillator and the beginning of discharge of the power amplifier. The reader should note that the energy scale of the ASE is smaller than that for the line narrowed light output.

[0098] Lithography customer specifications call for the ASE to be a very small fraction of the line narrowed laser output. A typical specification calls for the ASE to be less than 5.times.10.sup.-4 times the line narrowed energy for a thirty pulse window. As is shown in FIG. 5 the ASE is substantially zero when the narrow band pulse is maximum; i.e., in this case when the MO discharge precedes the PA discharge by between 25 and 40 ns. Otherwise, the ASE becomes significant.

[0099] As described above, the MO and the PA pulse power circuits can be triggered with a timing accuracy of about 2 ns so with good feedback information regarding the response of the two pulse power circuits, the MO and the PA can be discharged within the range where line narrowed

pulse energy is maximum and ASE is insignificant. Therefore, for continuous operation with good feedback control, control of the two systems is relatively easy. However, typical operation of these lasers is burst mode operation as described above. Therefore, the first pulse of a burst is likely to produce bad results because any feedback data will be out of date and temperature changes in the electrical components will likely affect their responses.

[0100] One solution is to initiate a test pulse prior to each burst (perhaps with the laser shutter closed) so that up-to-date timing data can be obtained. This solution is not desirable for several reasons including the delay associated with closing and opening the shutter.

[0101] A better solution is the one referred to briefly above in which the two chambers are caused to discharge at relative times chosen so that there can be no amplification of the output of the MO. This means, in the case of the system that is the subject of the FIG. 5 data, that the MO must be discharged later than about 40 ns after the PA is discharged or that the MO must be discharged earlier than 110 ns prior to the discharge of the PA. FIGS. 6 and 7 describe these two jitter control techniques.

[0102] In the FIG. 6 technique if more than one minute has elapsed since the previous pulse, the PA is discharged 110 ns after the MO is discharged. Otherwise the PA is discharged 30 ns after the MO is discharged to produce the desired pulse energy. The technique calls for collecting timing data, and feedback corrections are made for any changes in timing between trigger and discharge. The discharge are detected by photocells detecting discharge produced ASE light in both the MO and the PA.

[0103] In the FIG. 7 technique if more than one minute has elapsed since the previous pulse, the MO is discharged 40 ns after to the discharge of the PA. As before, timing data is collected and used to assure that discharges subsequent to the first pulse occur when they should to produce maximum narrow band output and minimum ASE.

[0104] Thus, the first pulses of each burst after more than a one minute idle time produces substantially zero line narrowed output on an extremely small amount of ASE. Applicants estimate that the ASE for pulse window of at least 30 pulse the ASE will be less than 2.times.10.sup.-4 of the integrated narrow band energy. Since pulses in this preferred laser are at the rate of 4000 pulses per second, the loss of a single pulse at the beginning of a burst of pulses is not expected to be a problem for the laser users.

Variations

[0105] Many modifications could be made to the procedures outline in FIGS. 6 and 7 to achieve similar results. The time values such as the 30 second targets shown of course should be chosen to provide best results. The 1 minute could be as small as a few milliseconds so that the first pulse of each burst is thrown away. In the FIG. 6 situations based on the FIG. 5 data, the 110 ns time period could be shortened to as much as about 70 ns and in the FIG. 7 situation the 40 ns time period could be as short as about 20 ns. The programs could be modified to provide for two or several no output discharges at the start of each burst or at the start of each burst following an extended idle period. Parameters other than the P-cell outputs threshold could be used to determine the times of beginning of discharge. For example, the peaking capacitor voltage could be monitored. The sudden drop in voltage soon after the beginning of discharge could be used as the time of start of discharge.

[0106] While the present invention has been described in terms of specific embodiments persons skilled in the art will recognize many modifications could be made within the general scope of the invention. For example, additional data could be collected to provide additional feedback information to possibly improve timing precision. It is known that temperature of the electrical components affect timing so the temperature of the components could be monitored and data collected could be correlated with historical timing data collected as a function of

> temperature and appropriate corrections could be included in the algorithms shown in FIGS. 6 and 7. Other techniques could be used to determine the timing responses of the pulse power components. For example, the saturable reactors in the pulse power circuits produce much of the timing variations. A test voltage could be applied across there reactors to determine their response and data collected could be used to correct discharge timing. Accordingly, the above disclosure is not intended to be limiting and the scope of the claims should be determined by the appended claims and their legal equivalents.

As noted in the M.P.E.P. §2173.05 (b):

> The fact that claim language, including terms of degree, may not be precise, does not automatically render the claim indefinite under 35 U.S.C. 112, second paragraph. ... Acceptability of the claim language depends on whether one of ordinary skill in the art would understand what is claimed, in light of the Specification.

Applicants submit that the above cited paragraphs from the Specification provide ample explanation to one of ordinary skill in the art the purpose of having the "at least a first set of discharges at the start of said burst of pulses ... occur at relative times so that no significant lasing results," ways to achieve this result and what it means to achieve this result in terms that are clear and understandable to one of ordinary skill in the art. References to such things as (1) passing the seed beam through the PA laser chamber when there is no population inversion (due to an electrical discharge in the laser gas between the electrodes), or (2) specific timing differences between MO and PA gas discharges between their respective electrodes, only generating ASE, as opposed to amplifying the narrow band seed pulse in the PA, or (3) measuring light out initially from the gas discharge in the PA because there is no lasing at all occurring, etc. amply describe what the phrase to which the Examiner objects means and the scope of the claimed invention.

The Specification makes clear that a reason behind the present invention is that, due to timing inaccuracies, due to relatively extended down time between the last and the

current laser pulse, the seed beam from the MO may transit the PA in such a way that there is no discharge occurring between the electrodes in the PA for at least some of that passage, and the resultant output laser pulse may be out of specification. A solution to this problem is noted to be the use of shuttering but with unsatisfactory limitations. Thus the present invention in concept is to intentionally mis-time the discharges in the MO and PA such that there is "no significant lasing" occurring at the output of the PA, meaning that there is no lasing at all, or that such lasing as occurs, without the need for shuttering, is not detected by a lithography tool to which the laser is attached as an output pulse that is out of specification. Thus those skilled in the art can gauge the appropriate level of allowable "no significant lasing," that fulfills the stated objectives of the invention.

As noted in the M.P.E.P. this is not a case where the specific degree of "no significant lasing" is the specific improvement over the art, and thus the adequacy of the disclosure of more specific standard is not of critical importance. This is, therefore, a case where not only does the Specification offer several standards for measuring "no significant lasing," but also one skilled in the art of laser lithography light sources can easily determine what "no significant lasing" means in the context of the rest of the explanation of the invention as disclosed and claimed.

The Examiner has also apparently rejected claim 27 under 35 U.S.C. §112, second paragraph, due to the claim "being incomplete for omitting essential steps ... ." This rejection is improper on its face based upon the cited M.P.E.P. §2172.01 and the case cited therein, *In re Mayhew,* 527 F.2d 1229, 188 U.S.P.Q. 356 (C.C.P.A. 1976). *In re Mayhew*, is a case, including the concurring opinion of Judge Baldwin and the cases cited therein, where the rejection was based on 35 U.S.C. §112, first paragraph, for lack of essential elements. In this event, the Specification must itself point out the elements missing from the claim are essential to the functioning of the claimed invention. Under 35 U.S.C. §112, second paragraph, as Judge Baldwin points out, the only requirement is that the claim be clear.

> 'The first sentence of the second paragraph of §112 is essentially a requirement for *precision* and *definiteness of claim language*. If the scope of subject matter embraced by a claim is clear, and if the applicant has not otherwise indicated that he intends the claim to be of a different scope, ...

> then the claim does particularly point out and distinctly claim the subject matter which the applicant regards as his invention. That is to say, if the "enabling" disclosure of a specification is not commensurate in scope with the subject matter encompassed by a claim, that fact does not render the claim imprecise or indefinite or otherwise not in compliance with the second paragraph of §112; rather, the claim is based on an insufficient disclosure (§112, first paragraph) and should be rejected on that ground. [citations omitted] Thus, just as a claim which is of such breadth that it reads on subject matter disclosed in the prior art is rejected under §102 rather than under the second paragraph of §112, a claim which is of such breadth that it reads on subject matter as to which the specification is not "enabling" should be rejected under the first paragraph of §112 rather than the second.[1]

Applicants have already addressed above why the rejection under 35 U.S.C. §112, second paragraph for indefiniteness is not proper.

For the above stated reasons, the rejections of claim 27 under 35 U.S.C. §112, second paragraph, for missing "essential elements" are not proper and the Examiner is respectfully requested to withdraw the rejections of claim 27 under 35 U.S.C. §112, second paragraph, and allow claim 27.

Claim 27 has also been rejected under 35 U.S.C. §102 as being anticipated by United States Published Patent Application No. 20020162973, published on November 7, 2002, with inventors Cordingley, James J. et al., entitled METHODS AND SYSTEMS FOR PROCESSING A DEVICE, METHODS AND SYSTEMS FOR MODELING SAME AND THE DEVICE, based on an Application Ser. No. 10/108,101, filed on March 27, 2002 ("Cordingly").[2]

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[1] *In re Mayhew*, 527 F.2d at 1237 (Baldwin, J. concurring, *citing*, *In re Borkowski*, 422 F.2d 904, 57 C.C.P.A. 946 (1970).

[2] It is not clear why Cordingly is even a §102 (a) reference, having been filed after the above captioned application. Cordingly does claim priority to a prior filed provisional application, but the Examiner has not demonstrated that common subject matter exists in that provisional application the material relied upon by the Examiner here.

After thorough reading of the entire Cordingly application it is difficult to find in Cordingly anything resembling the invention as claimed in claim 27. The specific paragraphs to which the Examiner refers, repeated below, also do not shed any light on how Cordingly relates to the present invention, much less anticipates the invention of claim 27.

The Abstract of Cordingly indicates that Cordingly is related to an entirely different technical problem and solution than the invention claimed in claim 27:

> A method and system for locally processing a predetermined microstructure formed on a substrate without causing undesirable changes in electrical or physical characteristics of the substrate or other structures formed on the substrate are provided. The method includes providing information based on a model of laser pulse interactions with the predetermined microstructure, the substrate and the other structures. At least one characteristic of at least one pulse is determined based on the information. A pulsed laser beam is generated including the at least one pulse. The method further includes irradiating the at least one pulse having the at least one determined characteristic into a spot on the predetermined microstructure. The at least one determined characteristic and other characteristics of the at least one pulse are sufficient to locally process the predetermined microstructure without causing the undesirable changes. (Abstract)

One of the cited paragraphs states:

> [0132] The temporal pulse shape is selected, in part, based on physical properties of the target microstructure 10, for instance, thickness, optical absorption, thermal conductivity, or a combination thereof. In an advantageous embodiment of the invention, the processing will occur with a single pulse having a fast edge leading relative to a selected pulse duration of several nanoseconds. In an alternative embodiment, the laser output may be a series of narrow q-switched or rectangular pulses, with very fast rise time, for example 800 ps pulses representative of the output of commercially available q-switch micro-lasers. The pulses may be

> delayed with respect to each other so as to provide a burst of pulses to irradiate the target structure. The laser output may be generated with a combination of a high bandwidth seed laser diode and fiber optic amplifier with Raman shifting, or with a waveguide amplifier system. Alternatively, a desirable pulse characteristic may be provided with various modified q-switched systems or with the use of high speed electro-optic modulators. Other pulse shapes may be selected for the material processing requirements. For instance, a sequence of closely spaced pulses having duration from a few picoseconds to several nanoseconds is taught in Reference 5.

The other cited paragraphs are actually part of a somewhat succinct statement of what Cordingly is about:

> [0222] In summary, one aspect of the invention is a method of selective material processing of a microscopic target structure with a pulsed laser beam. The target structure is separated from a substrate by a plurality of layers which form a multi-layer stack. The target structure, layers, and substrate have dissimilar thermal and optical properties. The method includes generating a pulsed laser beam with an energy density; irradiating the target structure with at least one pulse. Undesirable changes to the stack structure and substrate are avoided by selection of at least one pulse characteristic.
>
> [0223] A portion of the stack may be irradiated with the laser beam during the processing of the target structure, yet undesirable damage to the layers, substrate, and functional circuitry in a plane of the inner layers is avoided.
>
> [0224] Undesirable damage of the stack structure includes cracking, induced by thermal stress, of inner dielectrics. Undesirable damage to inner layer conductors of the stack includes thermal damage caused by irradiation. Undesirable damage to the substrate may arise from laser irradiation and resulting thermal diffusion.

[0225] The dielectric layers may include Silicon Nitride or Silicon Dioxide. The substrate may be Silicon.

[0226] The target structure is preferably copper, and may have thickness or width below one micron, with a dimension at or below wavelengths of visible light. Alternatively, the target structure may be a metal link, for instance aluminum, titanium, platinum, or gold.

[0227] An aspect of the invention is selection or control of the spatial and temporal beam characteristics of the pulse, which allows the target structure to be cleanly processed while avoiding undesirable damage to the layers, substrate, and functional circuitry in a plane of the inner layers.

[0228] A temporal characteristic of the pulse is the pulse shape. The pulse shape includes a rise time fast enough to efficiently couple laser energy into the target, a duration sufficient to cleanly remove a portion of the target structure, and a fall time fast enough to avoid undesirable damage caused by subsequent optical transmission. A preferred pulse rise time for link processing is less than 1 nanosecond (ns) to about 2 ns. A preferred duration is less than 10 ns. A fall time of less than 3 ns is preferred. The pulse shape may be substantially square, with ringing or variation between the rising and falling edges of about +-10%. A single pulse or multiple pulses in the form of a rapid burst may be used. Alternatively, a series of q-switched pulses spaced apart in time, with varying output power if desired, may be combined to form a pulse shape having a fast leading edge with high peak power, followed by a second pulse with lower power. In yet another embodiment of the present invention the q-switched pulses may have approximately the same output power and combined to produce a substantially square pulse shape.

How any of this from Cordingly relates in any way to the claimed invention as recited and as explained in the cited portions of the Specification of the above captioned application referenced in the Response filed on October 16, 2003 and above, is not apparent to applicants. Pulse shaping is simply completely different to relative discharge

timing between an MO and PA discharge to insure that early in a burst of pulses there will not be an unintentional mis-timing between the MO discharge and PA discharge that results in an output pulse from the PA that is out of specification.

As above noted, this is simply not at all related to the invention of the above captioned application as disclosed and claimed in claim 27, much less an anticipatory disclosure.

For the above stated reasons, the Examiner's rejection of claim 27 under 35 U.S.C. §102 (a) is improper and the Examiner is respectfully requested to withdraw the rejection of claim 27 under 35 U.S.C. §102 (a) and allow claim 27.

Conclusions

The Examiner has allowed claims 1-26 and applicants have demonstrated that the rejections of claim 27 under 35 U.S.C. §§102 (a) and 112, second paragraph, are improper, making claim 27 allowable. The Examiner is respectfully requested to withdraw the rejections of claim 27 and allow claim 27 along with claims 1-26.

Applicants do not believe that any fees or charges are due for the prosecution of this Response, but in the event that any fees are due, the Commissioner is hereby authorized to charge Cymer, Inc's., Deposit Account No. 03-4060 the appropriate amount(s).

Respectfully submitted,

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March 17, 2004

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